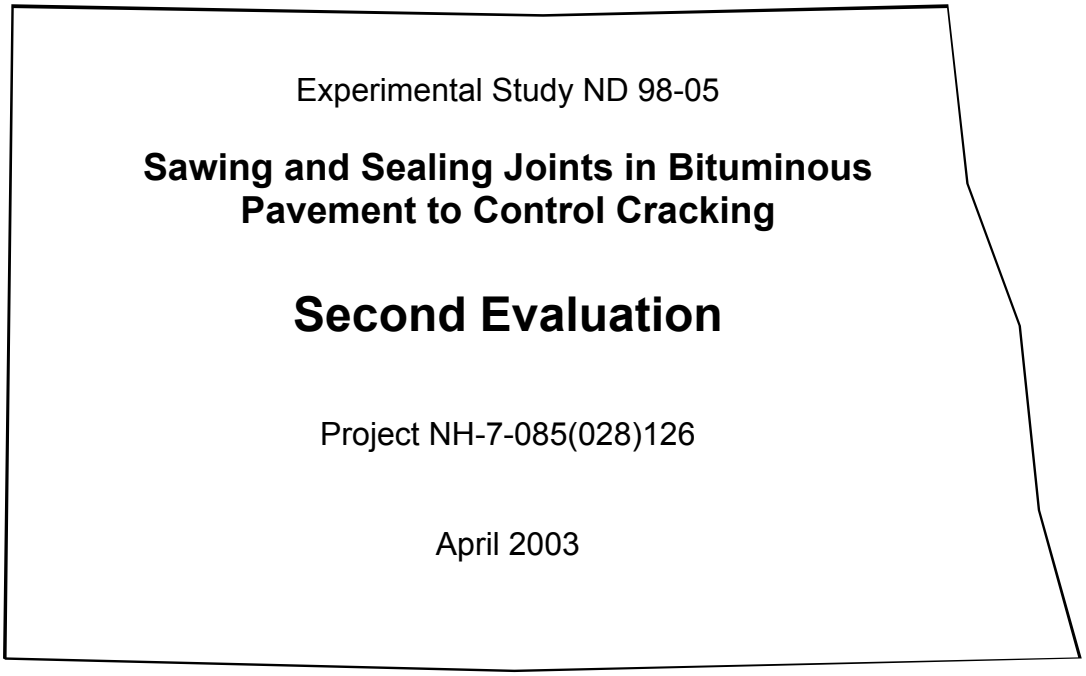
NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH DIVISION



Experimental Study ND 98-05

Sawing and Sealing Joints in Bituminous Pavement to Control Cracking

Second Evaluation

Project NH-7-085(028)126

April 2003

Prepared by

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

EXPERIMENTAL PROJECT REPORT

EXPERIMENTAL PROJECT

EXPERIMENTAL PROJECT NO.

1	STATE	YEAR		NUMBER		SURF
	ND	98	-	05		

CONSTRUCTION PROJ NO: 8 NH-7-085(028)126

LOCATION: McKenzie County 28

EVALUATION FUNDING (48)
1 **X** HP&R
2 CONSTRUCTION
3 DEMONSTRATION
4 IMPLEMENTATION

NEEP NO. (49)

PROPRIETARY FEATURE? (51)
Yes
X No

SHORT TITLE

TITLE (52): Sawing and Sealing Joints in Bituminous Pavement

THIS FORM

DATE (140): MO. 04 -- YR. 03

REPORTING: 1 INITIAL 2 **X** ANNUAL 3 FINAL

KEY WORDS

KEY WORD 1 (145): ASPHALT
KEY WORD 2 (167): PAVEMENT
KEY WORD 3 (189): JOINTS
KEY WORD 4 (211): OVERLAY
UNIQUE WORD (233): SAWING & SEALING
PROPRIETARY FEATURE NAME (255):

CHRONOLOGY

Date Work Plan Approved	Date Feature Constructed:	Evaluation Scheduled Until:	Evaluation Extended Until:	Date Evaluation Terminated:
02-98	10-98	10-08		
277	281	285	289	293

QUANTITY AND COST

QUANTITY OF UNITS (ROUNDED TO WHOLE NUMBERS): 14,510 linear feet (297)

UNITS (305):
1 **X** LIN. FT
2 SY
3 SY-IN
4 CY
5 TON
6 LBS
7 EACH
8 LUMP SUM

UNIT COST (*Dollars, Cents*): $1.25 per linear foot total=$18,137.50 (306)

AVAILABLE EVALUATION REPORTS

X -CONSTRUCTION	X -PERFORMANCE	FINAL
315		

EVALUATION

CONSTRUCTION PROBLEMS (318)
1 NONE
2 **X** SLIGHT
3 MODERATE
4 SIGNIFICANT
5 SEVERE

PERFORMANCE (319)
1 EXCELLENT
2 GOOD
3 SATISFACTORY
4 MARGINAL
5 UNSATISFACTORY

APPLICATION (320)

1 ADOPTED AS PRIMARY STD.
2 PERMITTED ALTERNATIVE
3 ADOPTED CONDITIONALLY
4 PENDING
5 REJECTED
6 NOT CONSTRUCTED

(Explain in remarks if 3, 4, 5, or 6 is checked)

REMARKS (321)

The pavement is in good shape. There is very minimal cracking where the joints were installed.

700

Form FHWA 1461

Experimental Study ND 98-05

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April 2003

Written by
Kyle Evert
Jeff M. Richter

Disclaimer

TABLE OF CONTENTS

Sawing and Sealing Joints in Bituminous Pavement to Control Cracking

Purpose and Need

The purpose of this project is to evaluate the ability to control random asphalt pavement cracking. Asphalt pavements are subjected to thermal distresses due to extreme low temperatures in the northern climate. These thermal distresses cause the formation of random unsealed cracks. Unsealed cracks allow moisture to infiltrate the subgrade and base. This moisture can cause the asphalt binder on the walls of the cracks to strip. This causes the pavement structure to weaken. The weakened pavement may form depressions at the cracks, which lead to bad ride characteristics.

Sawing joints into new asphalt pavements at regular intervals may help control the location of thermal cracking in flexible pavement. Sawed joints are easier to fill initially and maintain in the future. Early sawing and sealing joints into the pavement controls the infiltration and reduces the stripping of asphalts.

Objective

The objectives of this study are; to determine the effectiveness of sawing and sealing joints in bituminous paving to control random cracking, to determine the optimum spacing of the sawed joints, to evaluate the sealant, and to evaluate the construction practices used in the sawing and sealing.

Scope

Five different joint sections will be installed into the pavement. The joint spacing of the first three sections will be 30', 40', and 80' with Type A joint dimensions. The reservoir dimensions for Type A are 3/8" deep and 3/4" wide. The next section of joints will have 40' joint spacings and Type B joints with reservoir dimensions that are 5/8" deep and 3/4" wide. The last section will have 80' joint spacings and Type C joints with reservoir dimensions that are 3/4" deep and 3/4" wide. The control section will have no joints installed into the pavement. The pavement and joints will be evaluated annually for ten years from when it was constructed or until failure.

The success is scored by the ratio of sawed and sealed joints to the sawed and sealed joints added to the transverse cracks in between the joints, example:

$$\frac{\text{\# of Sawn Joints}}{\text{\# of Sawn Joints + \# of Cracks Between Joints}} \times 100 = \text{\% of Crack Control}$$

The North Dakota Department of Transportation is trying to achieve a success rate of 85% or greater.

Location

The location of the test sections are on ND Highway 85 in McKenzie County and included in Project NH-7-085(028)126 which begins at the Little Missouri River and continues north to Watford City. The beginning reference point is 126.6501 (station 6700 + 34) and the ending reference point is 141.0002 (station 7392 + 48) for a length of 14.728 miles. Figure 1 is a map displaying the project location and limits.

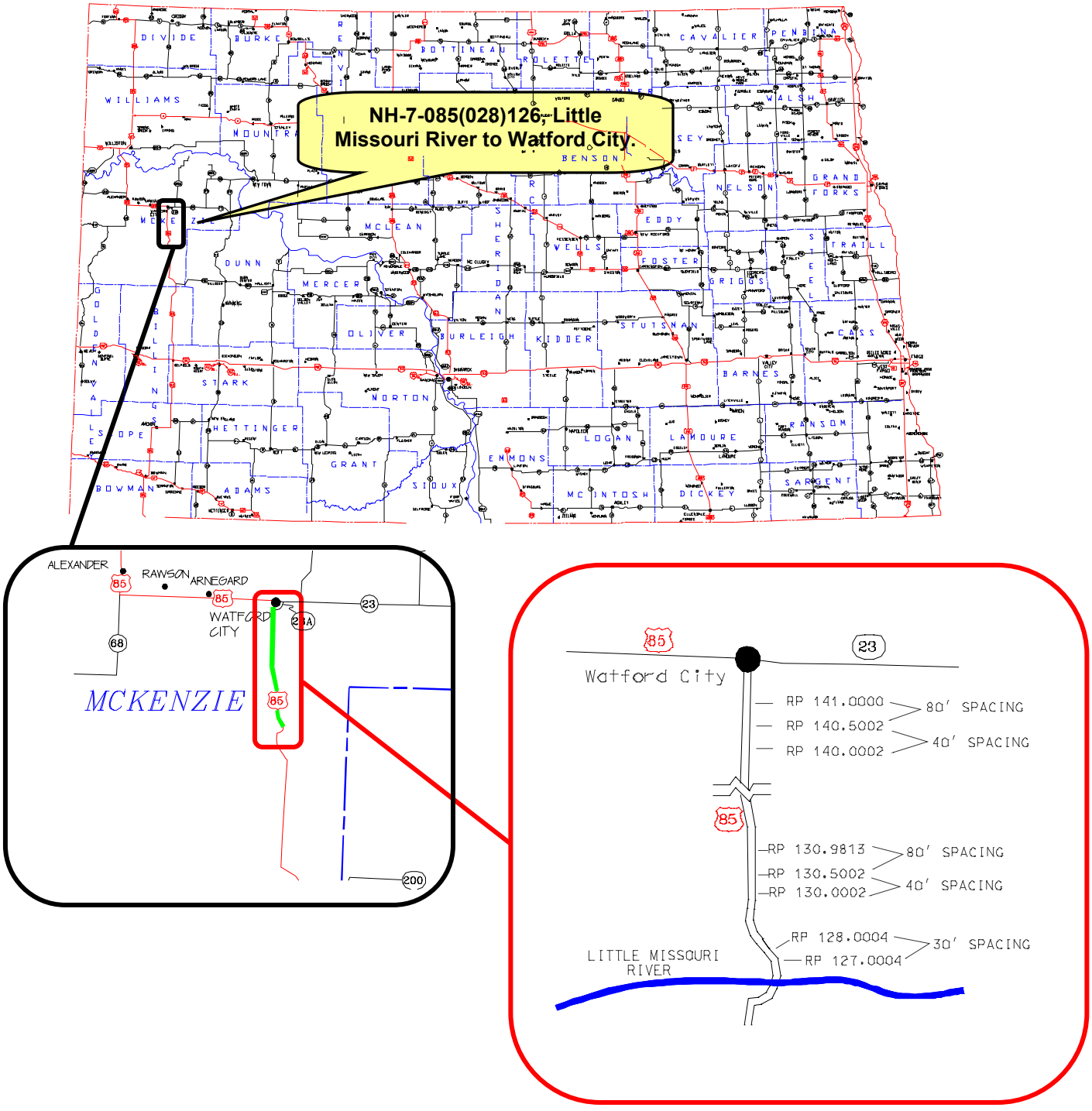


Figure 1 – Project Location

Project Historical Information

RIMS data

ND 85		Reference Point 126.7430 to Reference Point 130.0000				
Year	Components	Depth (in)	LSHLD WDTH (ft)	RDWY WDTH (ft)	RSHL WDTH (ft)	Oil
1983	Grade	-	-	54.0	-	-
1983	Aggregate Base	6.0	-	50.0	-	-
1984	Recycled Bituminous Base	2.5	-	46.0	-	SH-1H
1984	Recycled HBP	4.0	-	45.0	-	200-300
1985	Drive Slope Flattening	-	-	-	-	-
1988	Contract Chip Seal	-	-	45.0	-	HFMS - 2
1998	Blended Base	11.5	-	48.0	-	-
1998	HBP	5.0	-	36.0	-	PG 58 - 28
2002	Contract Chip Seal	-	6.0	24.0	6.0	HFMS - 2

Table 1

ND 85		Reference Point 130.0000 to Reference Point 142.2660				
Year	Components	Depth (in)	LSHLD WDTH (ft)	RDWY WDTH (ft)	RSHL WDTH (ft)	Oil
1960	Grade	-	-	44.0	-	-
1960	Emulsified Base	7.0	-	40.0	-	SS-1
1962	HBP	2.5	-	25.0	-	150-200
1977	HBP	2.0	-	38.0	-	120-150
1985	Drive Slope Flattening	-	-	-	-	-
1988	Contract Chip Seal	-	-	38.0	-	HFMS - 2
1998	Blended Base	11.5	-	48.0	-	-
1998	HBP	5.0	-	36.0	-	PG 58-28
2002	Contract Chip Seal	-	6.0	24.0	6.0	HFMS - 2

Table 2

Traffic

The one-way traffic for ND Highway 85 is shown below in table 3.

Year	Passenger Car	Trucks	Total	30TH Max Hr	Flexible ESALs
1997	1630	245	1875	230	180
2003	985	420	1405	145	310

Table 3

Design

The roadway was reconstructed with a mine and blend option. The base was constructed by blending existing aggregate base, existing asphalt, and additional virgin Class 5 aggregate to create a 11.5” base. The asphalt section is 5” of Class 31 Hot Bituminous Pavement (HBP). The asphalt binder used was PG 58-28.

Joints were sawed and sealed into the roadway to prevent cracking due to thermal contraction. Thermal contraction is the contracting of a material due to the change in temperature. There are three joint spacings between sawed and sealed joints; they are 30’, 40’, and 80’. These joint spacings were chosen to try to reproduce the lengths between the natural cracks formed by thermal contraction. This procedure helps to control where thermal cracking occurs in the pavement.

The beginning of the project has three sections of 30’, 40’, and 80’ joint spacing with Type A joints. The 30’ section has a length of one mile. The 40’ and 80’ sections each have a length of one half of a mile. The control section follows the three sections at the beginning of the project. The control section is approximately 9 miles long. Following the control section is a 40’ section with Type B joints and 80’ section with Type C joints, each section has a length of one half of a mile that proceeds to the end of the project. Figure 2 depicts the typical section of a sawed and sealed joint.

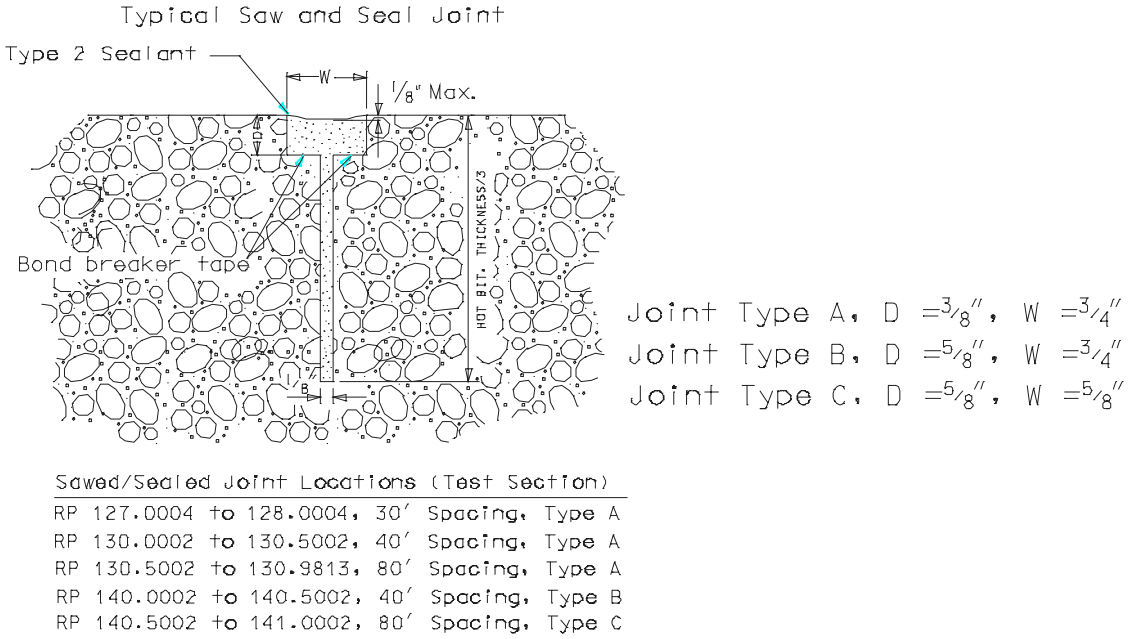


Figure 2 – Typical Saw and Seal Joint

The construction and material requirements for the sawed and sealed joints followed Special Provision-Joint Sawing and Sealing 41(97), which can be found in Appendix A. It was decided to utilize Backer Tape on this project but to have a test section without the Backer Tape to see if any difference in performance of the joint was noticed. The joints without backer tape are located at Reference Points 127.0288, 127.0345, 127.0402, 127.0458, and 127.0515.

Construction

Project NH-7-085(028)126 was constructed in the construction season of 1998. The project was located in Williston District on ND Highway 85 from Little Missouri River to Watford City. Northern Improvement was awarded the contract for a contract cost of $3,947,310.78 and was increased to $4,485,860.27 due to change orders and increased project quantities. Sawing and Sealing Joints was bid at $1.25 per linear foot and the total bid price for was $18,137.50.

Evaluation

Research project ND 98-05 was evaluated April 22, 2003. The research team that evaluated the research section included Steve Henrichs and Kyle Evert from Materials and Research Division of North Dakota Department of Transportation. The number of transverse cracks in between the sawed and sealed joints determines the success. The RIDE and Public Ride Perception Index (PPRI) scores from Pathways Van are included in the evaluation because the scores will reflect on the pavement distresses.

Reference Point 127.0004 to Reference Point 128.0004

This section has 30' joint spacings and Type A reservoirs in the joints. This section has a smooth ride and the joints are not depressed. The sealant is intact in the joints and still in good condition. A typical sawed and sealed joint can be seen in Photo 1. There are no cracks in this section. The success of this section can be seen in Table 4.

Section (RP)		Length of Section (ft)	# of Sawn Joints	# of Cracks between Joints	Success of Crack Control
127.0004	128.0004	30	176	0	100%

Table 4

Photo 1 – Sawed and sealed joint with no visible defects.

There are two patches on this section between the stations 6700+34 to 6753+14. These patches are approximately 50’ to 80’ in length and are in both lanes of the roadway. Each patch has a transverse crack in it. These cracks were omitted from the success calculation because the crack is formed from the reflection of the sawed and sealed joint beneath the patch. A patch can be seen in photo 2.

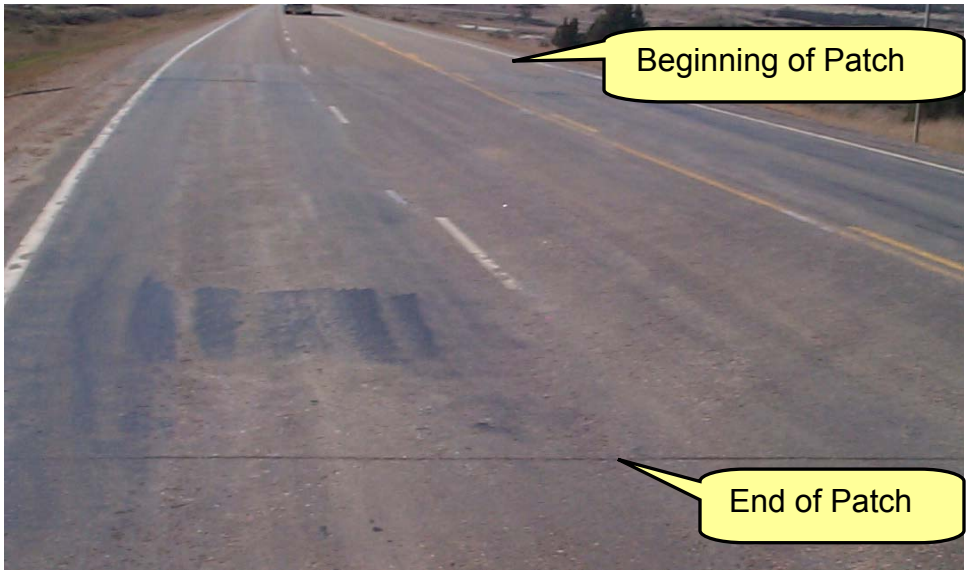


Photo 2- Patch that extends across both lanes.

The Pathways Van evaluated distresses for the whole project. The RIDE and Public Ride Perception Index (PPRI) are the different distress evaluations performed by the Pathways Van. The RIDE and PRPI scores for the whole project can be seen in Appendix B. The distresses for this project have not changed much since 1998, when the project was completed. The RIDE and PRPI differences for this section between 1998 and 2002 can be seen in Table 5.

Highway 85					
1998			2002		
RP	RIDE	PRPI	RP	RIDE	PRPI
127	3.97	GOOD	127	3.92	GOOD
RIDE Scale	Excellent	Good	Fair	Poor	
1997 - Present	4.01 - 5.00	3.25 - 4.00	2.50 - 3.24	0.00 - 2.49	

Table 5

Reference Point 130.0002 to Reference Point 130.5002

This section has 40' joint spacings and Type A reservoirs in the joints. This section has a smooth ride and the joints are not depressed. The sealant is intact in the joints and still in good condition. There are no cracks in this section. The success of this section can be seen in Table 6.

Section (RP)		Length of Section (ft)	# of Sawn Joints	# of Cracks between Joints	Success of Crack Control
130.0002	130.5002	40	66	0	100%

Table 6

The distresses evaluated by the Pathways Van for this section have not changed much since 1998, when the project was completed. The RIDE and PRPI differences for this section between 1998 and 2002 can be seen in Table 7.

Highway 85					
1998			2002		
RP	RIDE	PRPI	RP	RIDE	PRPI
130	4.11	GOOD	130	4.02	GOOD
RIDE Scale	Excellent	Good	Fair	Poor	
1997 - Present	4.01 - 5.00	3.25 - 4.00	2.50 - 3.24	0.00 - 2.49	

Table 7

Reference Point 130.5002 to Reference Point 130.9813

This section has 80' joint spacings and Type A reservoirs in the joints. This section has a smooth ride and the joints are not depressed. The sealant is intact in the joints and still in good condition. There is very minimal transverse cracking in this section. There is one crack in this section. The success of this section can be seen in Table 8.

Section (RP)		Length of Section (ft)	# of Sawn Joints	# of Cracks between Joints	Success of Crack Control
130.5002	130.9813	80	32	1	97%

Table 8

The distresses evaluated by the Pathways Van for this section have not changed much since 1998, when the project was completed. The RIDE and PRPI differences for this section between 1998 and 2002 can be seen in Table 9.

Highway 85					
1998			2002		
RP	RIDE	PRPI	RP	RIDE	PRPI
130	4.11	GOOD	130	4.02	GOOD
RIDE Scale	Excellent	Good	Fair	Poor	
1997 - Present	4.01 - 5.00	3.25 - 4.00	2.50 - 3.24	0.00 - 2.49	

Table 9

Reference Point 140.0002 to Reference Point 140.5002

This section has 40' joint spacings and Type B reservoirs in the joints. The Type B reservoirs have 5/8" depth as compared to the 3/4" depth in Type A reservoirs. This section has a smooth ride and the joints are not depressed. The sealant is intact in the joints and still in good condition. There is very minimal transverse cracking in this section. There is one crack in this section. This crack may have been caused by the

Photo 4 – Crack next to an approach.

approach next to the roadway. The crack can be seen in Photo 4. The approaches or intersections can cause a crack that is angled across the roadway as seen in Figure 4. A possible solution to these cracks next to the approaches or intersections is to saw a transverse joint on the roadway where the intersection or approach meets the roadway. The success of this section can be seen in Table 10.

Section (RP)		Length of Section (ft)	# of Sawn Joints	# of Cracks between Joints	Success of Crack Control
140.0002	140.5002	40	66	1	99%

Table 10

The distresses evaluated by the Pathways Van for this section have not changed much since 1998, when the project was completed. The RIDE and PRPI differences for this section between 1998 and 2002 can be seen in Table 11.

Highway 85					
1998			2002		
RP	RIDE	PRPI	RP	RIDE	PRPI
140	4.38	GOOD	140	4.5	EXCL
RIDE Scale	Excellent	Good	Fair	Poor	
1997 - Present	4.01 - 5.00	3.25 - 4.00	2.50 - 3.24	0.00 - 2.49	

Table 11

Reference Point 140.5002 to Reference Point 141.0002

This section has 80' joint spacings and Type C reservoirs in the joints. The Type C reservoirs have 5/8" depth and 5/8" width as compared to the 3/4" depth and width in Type A reservoirs. This section has a smooth ride and the joints are not depressed. The sealant is intact in the joints and still in good condition. There is very minimal transverse cracking in this section. There are four cracks in this section. These four cracks are next to an approach or intersection. The success of this section can be seen in Table 12.

Section (RP)		Length of Section (ft)	# of Sawn Joints	# of Cracks between Joints	Success of Crack Control
140.5002	141.0002	80	33	4	88%

Table 12

The distresses evaluated by the Pathways Van for this section have not changed much since 1998, when the project was completed. The RIDE and PRPI differences for this section between 1998 and 2002 can be seen in Table 13.

Highway 85					
1998			2002		
RP	RIDE	PRPI	RP	RIDE	PRPI
140	4.38	GOOD	140	4.5	EXCL
RIDE Scale	Excellent	Good	Fair	Poor	
1997 - Present	4.01 - 5.00	3.25 - 4.00	2.50 - 3.24	0.00 - 2.49	

Table 13

Reference Point 130.9813 to Reference Point 140.0002 – Control Section

The control section limits of this research project are from RP 130.9813 to RP 140.0002. This is the entire roadway between the two sawed and sealed sections at the beginning and the end of the project. This section appears to be in good shape and the cracks were not depressed. We counted 30 cracks throughout the control section. There is no definite pattern to the transverse cracks except that there were cracks near approaches. Photo 6 depicts a random transverse crack in the control section.

Photo 6 – Transverse crack across roadway in control section.

Summary

The pavement of this roadway is in good condition. There is very minimal cracking in the whole project. Most of the cracking that is in the test section appears to be caused by an approach or an approaching road. The test sections scored very well in the percent of crack control for the sawed and sealed joints. The control section did not have many cracks. The cracks in the control section did not have a definite pattern were they would appear.

The different RIDE and PRPI scores have also performed well for both the test sections and control section. Appendix B displays the RIDE and PRPI scores rated against each other. The roadway in this project is in good condition.

Appendix A

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

JOINT SAWING AND SEALING

ACNH-7-085(028)126

April 17, 1998

DESCRIPTION

This work consists of saw cutting, cleaning, drying and sealing transverse joints into new bituminous pavement according to the plans and the NDDOT specifications.

MATERIALS.

Sealant. Joint material shall be a "Type 2 - Hot Applied Joint Sealant" and shall meet the requirements of Section 826, except modified herein.

EQUIPMENT.

General. The melting kettle shall be double jacketed boiler type, equipped with both agitation and recirculation systems capable of melting and applying the sealant through a pressure-fed hose and wand. The melter shall be capable of starting at ambient temperature and bringing the sealing material to application temperature in one hour or less, while continuously agitating and recirculating the sealant. The melter shall be equipped with automatic thermostatic controls and temperature gages to monitor the sealant temperature in the applicator lines and temperature of heat transfer oil in the kettle jacket.

The air compressor shall be capable of producing a continuous stream of clean, dry air through the nozzle at 87 psi (600 kPa) and 38 ft^3/ft (3.5 m^3/m) minimum. The compressed air unit shall be equipped with water and oil traps and must produce sufficient air volume and pressure to remove all debris from the sawed joint and all adjacent road surfaces in a safe manner such that the debris will not re-enter the joint prior to the sealing operation.

The heat lance shall operate with propane and compressed air in combination and be capable of achieving a heated air temperature of 1800 °F (1000 °C) at the exit orifice and a discharge velocity of 3280 ft/s (1000 m/s).

A self-propelled power saw capable of providing a straight cut of uniform depth and width shall be used. Diamond saw blades with either single or gang blade arrangement shall be used. The power saw shall cut in a downward motion. The saw blade or blades shall be of such size and configuration that the desired joint reservoir shape and deep saw cut are achieved in one pass of the saw. Two pass cutting will not be allowed. No spacers between blades shall be allowed unless the Contractor can show that the desired reservoir and saw cut can be obtained with them.

CONSTRUCTION REQUIREMENTS.

General. The Contractor shall conduct the operation so that saw cutting of transverse joints, cleaning, and sealing are a continuous operation. Traffic shall not be allowed to knead together or damage the sawed joints. Sawed joints not sealed before traffic is allowed on the pavement shall be re-sawed, if necessary, at no additional cost to the NDDOT. The joints shall be sealed when the sealant material is at the pouring temperature recommended by the manufacturer. The contractor shall fill the joint such that after cooling, the sealant is flush with the adjacent pavement along the edges and the center does not sag more than 1/8" (3 mm) below the pavement of shoulder surface.

Care must be taken to ensure that the joints are not overfilled and the final appearance shall present a neat fine line. The applicator wand shall be returned to the machine and the joint sealant material recirculated immediately upon completion of each joint sealing. The Engineer may require a squeegee to force the material into narrow joint openings if, in the opinion of the Engineer, the material is not flowing into the joint properly.

Sand shall not be spread on the sealed joints to allow for early opening to traffic. The sealant shall be tack free before opening to traffic.

A given quantity of sealant material shall never be heated at the pouring temperature for more than six hours and shall never be reheated. The contractor shall record the temperature of the kettle and the temperature of the sealant once every hour during sealing and shall report the temperatures to the engineer. Temperatures recorded more than 40 °F (4 °C) above the manufacturers specifications shall result in rejection of the material in use, and the contractor shall dispose of the overheated material in an acceptable manner.

Breaker Tape will be allowed on this project.

Sawing. Each joint shall be cut in one pass and meet the following criteria:

Each saw cut shall be either wet sawed with the following procedures used:

1. Flush the sawed joint with high pressure water until the water runs clear.
2. Clean and dry the joint with compressed air removing all loose material.
3. Heat the joint with a hot-air lance immediately before sealing.

Or dry sawed with the following procedures used:

1. Clean the joint with compressed air removing all loose debris.
2. Heat the joint with a hot-air lance immediately before sealing.

While heating pavement with the lance, be careful not to burn the pavement surface. No more than two minutes shall elapse between the time the hot air lance is used and the sealant is placed.

The contractor shall wait 48 hours, from the time the pavement was placed, before sawing the joints.

Weather Limitations. The weather limitations shall be specified in Section 826.01.

ACCEPTANCE.

Sealed joints shall be rejected if there is evidence of poor workmanship or obvious defects, such as, but not limited to the following:

1. Sawed joint not filled completely
2. Lack of bond to the sides of the joint
3. Excessive debris or moisture in the joint
4. Contamination of the sealant
5. Sawed joint not filled flush

Rejected sealed joints shall be repaired, the sealant removed and disposed of in an appropriate manner, and the joints resealed to the Engineer's satisfaction at no additional cost to the NDDOT.

METHOD OF MEASUREMENT.

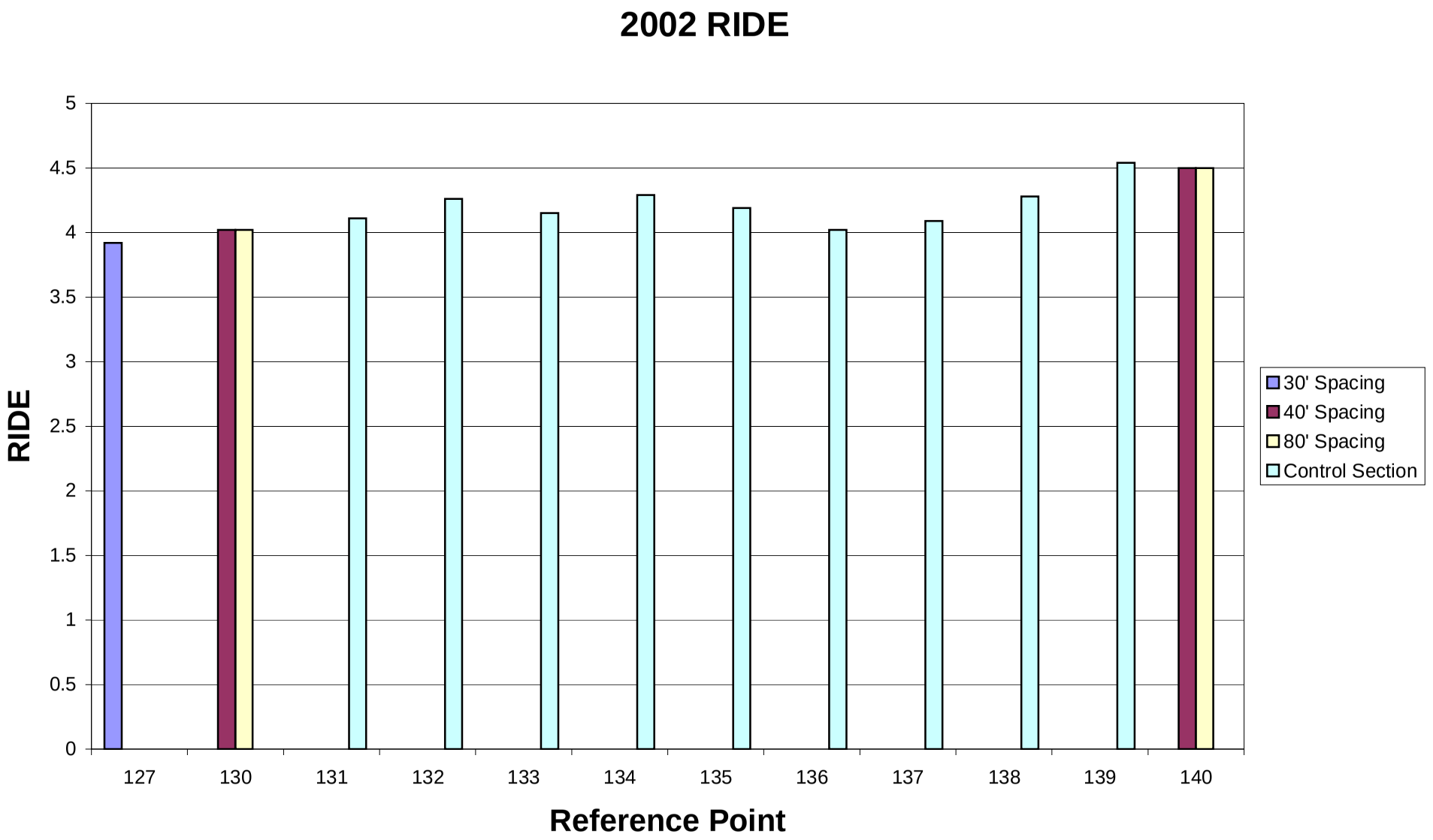
This item will be measured by the lineal feet of sawed and sealed joints. Payment shall be full compensation for all labor, equipment, and materials necessary to complete the work as specified.

BASIS OF PAYMENT.

Pay Item	Pay Unit
Sawing and Sealing Joints	Linear Foot

Appendix B

Highway 85					
1998			2002		
RP	RIDE	PRPI	RP	RIDE	PRPI
127	3.97	GOOD	127	3.92	GOOD
128	3.99	GOOD	128	3.99	GOOD
129	NA	NA	129	NA	NA
130	4.11	GOOD	130	4.02	GOOD
131	4.15	GOOD	131	4.11	GOOD
132	4.26	GOOD	132	4.26	GOOD
133	4.11	GOOD	133	4.15	GOOD
134	4.25	GOOD	134	4.29	GOOD
135	4.19	GOOD	135	4.19	GOOD
136	4.03	GOOD	136	4.02	GOOD
137	4.12	GOOD	137	4.09	GOOD
138	4.18	GOOD	138	4.28	GOOD
139	4.37	GOOD	139	4.54	GOOD
140	4.38	GOOD	140	4.5	EXCL
RIDE Scale	Excellent	Good	Fair	Poor	
1997 to Present	4.01 - 5.00	3.25 - 4.00	2.50 - 3.24	0.00 - 2.49	


2002 RIDE
RIDE
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
127
130
131
132
133
134
135
136
137
138
139
140
Reference Point
30' Spacing
40' Spacing
80' Spacing
Control Section